Continuous Enrollment Conservation Reserve Program

The Value of Buffer Habitats for Birds in Agricultural Landscapes

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Savannah sparrow (K. Hollingsworth)

Abstract

Conservation buffers, implemented through the Continuous Enrollment Conservation Reserve Program, are very actively promoted by the USDA under the Buffers Initiative. The best indication of how wildlife populations may be influenced by this program is provided by studies of bird communities in various strip-cover habitats. Bird abundances and nest densities are higher in strip-cover than in block-cover habitats, although nest success in the former is often very low. Birds' use of habitats depends upon vegetation structure (height and density) and species composition (herbaceous vs. woody, grass vs. forb, native vs. introduced). Some bird species are limited by the width of strip-cover habitats, thus there is a positive relationship between bird species richness and strip-cover width. Contributing to this may be the aversion that some bird species have for habitat edges. Vegetation management practices (e.g., mowing and grazing) influence bird communities both directly and indirectly. The amount of grassland surrounding herbaceous strips influences the occurrence and nesting success of birds in the strip cover. Rates of nest predation and brood parasitism by brown-headed cowbirds increase near wooded edges. Because some strip-cover habitats may function as ecological traps, there is an urgent need to identify and evaluate bird source and sink subpopulations in agricultural landscapes. Land-use decisions may vary depending upon wildlife management objectives, thus planning and evaluation of buffers will require a clear statement of conservation goals.

Introduction

Since the fall of 1996, landowners have been compensated under the Continuous Enrollment Conservation Reserve Program for enrolling small acreages into selected conservation practices. These practices include filter strips, contour buffers, riparian (streamside) forest buffers, grassed waterways, field windbreaks, shelterbelts, living snow fences, shallow water areas for wildlife, crosswind trap strips, and wellhead protection areas (USDA 2000). The goals of the Continuous Enrollment Conservation Reserve

Program are to protect soil, improve air and water quality, conserve biodiversity, beautify the landscape, and enhance fish and wildlife habitat. Eligible conservation practices, generally linear in configuration, are designed to buffer adjacent land uses, especially waterways, from the effects of agriculture. The U.S. Department of Agriculture has set a goal of establishing two million miles of conservation buffers by 2002. USDA incentives to encourage participation in the Buffers Initiative have been well received by landowners. In Iowa, for example, one in four landowners are presently participating in the Continuous Enrollment Conservation Reserve Program (Duane Miller, USDA Natural Resources Conservation Service, personal communication).

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Except for grassed waterways, field windbreaks, and shelterbelts, information on wildlife responses to Continuous Enrollment Conservation Reserve Program practices, especially filter strips and riparian forest buffers, is limited. Consequently, the best indication that we have about how wildlife populations may be influenced by the Continuous Enrollment Conservation Reserve Program is provided by studies of other strip-cover habitats. In particular, bird communities have been studied in grassed waterways, herbaceous roadsides, and terraces associated with Midwest agricultural rowcrop fields. This report will focus on the findings of these and other related studies and their potential application to the establishment of conservation buffers.

Riparian forest buffer in Iowa (L. Betts)

Bird Species Composition and Abundance in Strip-cover Habitats

Bird abundances in herbaceous strip-cover habitats are consistently higher than those in rowcrop fields (often by over an order of magnitude) and usually higher than those in other grassland block cover (Table 1). The difference between strip cover and block cover is even more pronounced relative to nest abundance (see Bird Nest Densities and Nesting Success in Strip-cover Habitats section). Among various strip-cover habitats, bird abundance and species composition differ and may be related to strip width (see Bird Response to Habitat Area and Strip Width section) and other management practices (see Vegetation Management section). Of the herbaceous strip-cover habitats studied (Table 1), grassed waterways attract the greatest variety of birds; 48 species have been recorded using waterways and 11 species are known to nest there. Not unexpectedly, bird abundance and species richness also have been reported to be greater in wooded strip-cover than in rowcrop fields (Gillespie et al. 1995). Furthermore, the presence of woody plants in strip-cover habitats increases the vertical structure and heterogeneity of the vegetation. This results in an increase in bird species diversity and abundance over what is found in herbaceous strip cover (e.g., Best 1983, Arnold 1983, Paruk 1990).

Bird Nest Densities and Nesting Success in Strip-cover Habitats

Nest densities in herbaceous strip-cover are much greater than those in block cover with comparable vegetation. In some herbaceous strip-cover habitats in Iowa (e.g., grassed waterways and herbaceous roadsides) nest densities can exceed 1,000 nests/100 ha, densities far greater than what have been found in rowcrop fields or even CRP fields (Table 1). Furthermore, in other studies pheasant nest densities have consistently been documented to be higher in strip-cover habitats (e.g., fencerows, roadsides, drainage ditches) than in block-cover habitats (e.g., hayfields, small grains, pastures, wetlands) of the agricultural landscape (South Dakota, Trautman 1960; Wisconsin, Gates and Ostrom 1966; Minnesota, Chesness et al. 1968; Illinois, Warner et al. 1987). Higher nest densities in strip versus block cover also have been reported for wooded plant communities (Shalaway 1985).

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Despite the high nest densities in strip-cover habitats, breeding productivity may be low. Studies have shown that nest failure rates may be higher in narrow strip-cover habitats than in block-cover habitats with comparable vegetation. This has been documented in both wooded (Vander Haegen and Degraaf 1996, Major et al. 1999) and grassed strip cover. In the Iowa studies, apparent nest success for grassed waterways, roadsides, and terraces was 15, 28, and 9%, respectively (Bryan and Best 1994, Camp and Best 1994, Hultquist 1999), compared with 38% in CRP fields with comparable plant cover (Patterson and Best 1996). In all cases the major cause of nest failure was predation, and predation was particularly intense in terraces, the narrowest of the strip-cover habitats evaluated (Fig. 1). Other studies have reported that, with the exception of crops subject to harvesting during the nesting season, nesting success for pheasants is lowest in herbaceous strip-cover habitats (Gates and Ostrom 1966, Chesness et al. 1968). Similarly, nesting success of waterfowl has been observed to be greater in blocks of upland habitat than in strip cover (Nelson and Duebbert 1973, Pasitschniak-Arts and Messier 1996).

Several explanations have been given for why predation rates may be elevated in strip-cover. These include: (1) predators may be more abundant in strip-cover habitats (Major et al. 1999), (2) predators may use strip cover as travel lanes (Fritzell 1978, Wegner and Merriam 1979), (3) predator search efficiency may be greater in strip cover because it has essentially a one-dimensional configuration (Major et al. 1999), and (4) predators may forage more intensively in areas with higher prey density (i.e., density-dependent predation) (Tinbergen et al. 1967, Gates and Gysel 1978, Warner et al. 1987, Sugden and Beyersbergen 1986, Martin 1988). Relative to the last mentioned explanation, cowbirds also may show a density-dependent functional response to potential hosts (Johnson and Temple 1990).

Poor nesting success in strip-cover habitats has raised concern that in some instances they may function as ecological traps (Gates and Gysel 1978) in that they attract high densities of breeding birds but may provide suboptimal conditions for nesting success. The potential drawbacks of strip-cover habitats are often determined by how the strip cover is designed and managed (see Bird Response to Habitat Area and Strip Width and Management Considerations sections).

Bird Response to Vegetation Structure and Composition

Grassland birds respond strongly to structural features (height and density) of the vegetation, and each species has its own unique requirements.

Grassland birds respond strongly to structural features (height and density) of the vegetation, and each species has its own unique requirements. The habitats preferred by grassland bird species range from low, sparse plant cover (e.g., horned lark, vesper sparrow) to tall, dense vegetation (e.g., sedge wren, Henslow's sparrow) (Skinner et al. 1984, Herkert et al. 1993, Swanson 1996, Sample and Mossman 1997). Accordingly, bird use of strip-cover habitats depends upon the structure of the vegetation (e.g., Camp and Best 1993, Bryan and Best 1994). Factors that influence vegetation structure include the plant species composition and various management practices such as mowing, grazing, and burning (Herkert et al. 1996).

In addition to structural features of the vegetation, birds respond to plant species composition (Skinner et al. 1984, Herkert et al. 1993, Swanson 1996, Sample and Mossman 1997). Of particular importance to grassland birds is the ratio of grasses to broad-leaved herbaceous plants (hereafter, forbs) and the presence of woody vegetation. The response of birds to the grass:forb ratio is well illustrated by the changes in bobolink and dickcissel abundances that parallel successional changes in hayfields and CRP fields. Over time, forb cover decreases and grass cover increases, with a concomitant decrease in dickcissel abundance and increase in bobolink numbers (Bollinger 1995, Patterson and Best 1996). Warner et al. (1987) reported that ring-necked pheasants prefer to nest in roadsides with a grass-legume mixture over those with only grass cover. Similar results have been reported for passerines (songbirds) (Paruk 1990, Warner 1992). The presence of woody vegetation, although attractive to woodland-edge birds, may adversely affect grassland species. This is illustrated by the propensity of some grassland birds (e.g., bobolinks, Henslow's and grasshopper sparrows) to avoid wooded edge habitats (Delisle and Savidge 1996, Helzer 1996, Winter et al. 2000). Lastly, bird habitat use may differ among grasslands composed of native versus introduced plant species (Delisle and Savidge 1997; McCoy et al., in press).

Bird Response to Habitat Area and Strip Width

Several studies have documented a positive relationship between bird species richness (and probability of occurrence of certain species) and the size of grassland areas (hereafter, patch size) (Johnson and Temple 1986, Herkert 1994, Vickery et al. 1994, Swengel 1996, Helzer and Jelinski 1999, Renfrew

1999, Walk and Warner 1999). In particular, upland sandpipers, savannah sparrows, grasshopper sparrows, Henslow's sparrows, bobolinks, and eastern and western meadowlarks have been shown to be area sensitive (i.e., have minimum area requirements). In contrast, certain edge species commonly associated with grasslands (e.g., common yellowthroat, song sparrow, red-winged blackbird, American goldfinch) may be negatively affected by patch area. The occurrence of others (e.g., ring-necked pheasant, sedge wren) seemingly is not influenced by patch size.

Iowa filter strip (L. Betts)

Species sensitivity to grassland patch size may be manifest not only at the distributional level (i.e., presence-absence, relative abundance) but also relative to nesting success (demographic level) (Winter and Faaborg 1999). Studies have shown that nest predation rates for grassland birds are lower in large grassland patches compared with small ones (Johnson and Temple 1990, Greenwood et al. 1995, Winter et al. 2000).

For strip-cover habitats, a factor limiting bird use may not be area (strip-cover habitats can be many miles long) but rather the width of the habitat. Information on bird response to buffer width is better for woodland than for grassland communities. Researchers in a variety of locations have reported a positive relationship between the number of bird species (particularly Neotropical migrants) and the width of riparian forests (Stauffer and Best 1980, Keller et al. 1993, Dickson et al. 1995, Hodges and Krementz 1996, Kilgo et al. 1998). Limited information for grasslands can be gleaned from a few studies. Stauffer and Best (1980) reported a positive relationship between bird species richness and the width of herbaceous riparian habitats. When comparing interstate and secondary roadsides, Warner (1992) found that for passerines the nest densities and the number of nesting species increased with roadside width. In contrast, Carroll and Crawford (1991) reported that roadside width did not significantly influence nest-site selection by gray partridge. Renfrew (1999) documented occurrence and abundance of grassland birds in 10-m-wide filter strips and block-cover pastures and found the fewest species in the former. Bobolinks, eastern meadowlarks, and sedge wrens did not occur in the filter strips but were present in block-cover pastures.

Bird communities have been studied in three strip-cover habitats associated with Iowa rowcrop fields: terraces, herbaceous roadsides, and grassed waterways (Table 1). Although conducted in different years, these studies used similar research techniques. The predominant vegetation was smooth brome grass, and the three habitats represent a range of strip widths (Figure 1). A comparison among the three strip-cover habitats clearly shows that some bird species (e.g., bobolink, grasshopper sparrow, western meadowlark) do respond to strip width. This response may take the form of (1) increased abundance (or frequency of occurrence) with greater strip width or

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(2) restriction of nesting to wider strips. Although the responses of individual bird species to strip width parallel what has already been documented for patch area (see Bird Response to Habitat Area and Strip Width section), a critical information void is the specific width requirements for area sensitive species. Managing the width of strip cover to reduce edge-related predation and brood parasitism (see Proximity to Woody Vegetation section) could enhance the suitability of these habitats for breeding birds.

Edge Aversion in Birds

One factor contributing to habitat width sensitivity in birds is aversion to edges. Helzer and Jelinski (1999) found that the perimeter:area ratio of patches had more influence on the presence and richness of grassland bird species than did patch area, which suggests that proximity to edge may deter use of grasslands by some birds. By virtue of their design, strip-cover habitats have much greater perimeter:area ratios than block-cover habitats and, in the case of narrow strip cover, may consist entirely of edge. Studies have verified that some grassland bird species (e.g., grasshopper sparrow, bobolink, Henslow's sparrow, horned lark) either avoid nesting and(or) have reduced abundance near edges, particularly those that are wooded (Clark and Karr 1979, Johnson and Temple 1986, Delisle and Savidge 1996, Helzer 1996, Winter et al. 2000, O'Leary and Nyberg 2000).

Management Considerations

Vegetation Management

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Controlled, periodic treatments (e.g., mowing, grazing, fire) to revitalize plant cover are necessary for the long-term maintenance of grassland habitats. These management approaches can influence bird communities both directly and indirectly. Mowing has two main effects on grassland birds: (1) it causes nest failure, loss of broods, and sometimes adult mortality, and (2) it alters the vertical structure of the vegetation. Inopportune mowing during the nesting season can have devastating effects on bird nesting success (e.g., Frawley 1989, Bollinger et al. 1990, Bryan and Best 1994). The frequency and extent to mowing determine the structure of the vegetation and, consequently, the composition of the bird community (see Bird Response to Vegetation Structure and Composition section). Furthermore, mowing causes site abandonment by some species, and recolonization may or may not take place depending upon the particular bird species and the degree of vegetative regrowth (Bollinger et al. 1990, Frawley and Best 1991). Mowing strip-cover habitats (e.g., grassed waterways) may be particularly problematic because these sites may represent renesting opportunities for birds that have experienced nest failure in hayfields earlier in the breeding season (Bryan and Best 1994).

Grazing can affect nesting birds indirectly by altering vegetation structure and directly through trampling or disturbing nest sites. The intensity and frequency of grazing determine the degree to which vegetation height is altered, and there is the potential, particularly for rotational grazing systems, of creating structural heterogeneity that may attract a wider variety of grassland bird species (Skinner et al. 1984). The likelihood that nests will be destroyed by trampling depends upon livestock density and duration of grazing (Jensen et al. 1990). Burning is frequently used to control woody plant encroachment in grasslands, and the denser regrowth of grassland vegetation after burning may reduce nest predation by restricting activity of nest predators and providing better nest concealment (Johnson and Temple 1990, Mankin and Warner 1992).

Contour buffers in Iowa (L. Betts)

After initial seeding, vegetation in some grassland habitats (e.g., CRP fields, hayfields) undergoes successional changes in composition and structure unless the process is disrupted by land management practices. Over time, the forb component (including legumes) diminishes and grass cover increases (Basu et al. 1978, Bollinger 1995, Patterson and Best 1996, Millenbah et al. 1996). Also a litter layer develops over time (Millenbah et al. 1996) which creates a mechanical barrier to grass development and decreases the vigor of the grassland stand (Rice and Parenti 1978). These changes influence the composition of the avian community on such sites (see Bird Response to Vegetation Structure and Composition section). Warner et al. (1987) reported that late season mowing can enhance the competitive ability and, thus, longevity of legumes in a grass-forb planting.

The Landscape Context

The value of grassland strip cover to birds may depend upon the landscape context (i.e., the surrounding land cover). Areas dominated by intensive rowcrop agriculture will differ from those with substantial amounts of pastureland, hayfields, and CRP fields. The availability of block-cover grassland habitats within the agricultural landscape can influence the occurrence and nesting success of birds in strip-cover habitats. For example, in Illinois pheasants were more likely to nest in roadsides when the roadsides were near other prime breeding habitats (hayfields, small grains) (Warner and Joselyn 1986, Warner et al. 1987). In contrast, densities of passerine nests in roadsides were highest where forage crops were relatively distant from roadsides and when small grain production was low regionally (Warner 1992). Warner (1994) also found that nest success of pheasants in strip cover was positively related to the amount of grass cover (including hay and small grains) in the landscape.

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Proximity to Woody Vegetation

Several studies of birds in grassland habitats have shown that rates of nest predation and brood parasitism by the brown-headed cowbird are higher near wooded edges (or trees) than farther away (i.e., nest success decreases closer to edges) (Best 1978, Gates and Gysel 1978, Moller 1989, Johnson and Temple 1986, 1990, Berg et al. 1992, Burger et al. 1994, Winter et al. 2000; but see Soderstrom et al. 1998). This may, in part, explain the avoidance of edges (or woody vegetation) by some grassland bird species (see Edge Aversion in Birds section). Cowbirds and avian predators use shrubs and trees as elevated perches from which to locate and monitor nests of potential hosts/prey (Payne 1973, Norman and Robertson 1975, Berg et al. 1992). Furthermore, the activity of potential nest predators may be greater near wooded edge habitats (e.g., Forsyth and Smith 1973, Bider 1968, Winter et al. 2000). Predation and parasitism rates are often significantly greater within 50 m of an edge (Paton 1994). Studies also have reported that proximity to wooded edges was more important than habitat patch size in determining grassland bird nest success (Burger et al. 1994, Winter et al. 2000). Presence of woody vegetation (either intentionally planted or resulting from encroachment) in strip-cover habitats, such as filter strips and riparian buffers, may profoundly influence the habitat suitability for grassland birds.

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Sources or Sinks

Bird populations in agricultural landscapes may consist of a network of source and sink subpopulations. The within-habitat reproduction in sink subpopulations is insufficient to balance local mortality, whereas the source subpopulations produce a surplus of individuals. Thus, the more productive source areas effectively subsidize or rescue unproductive sink areas (Pulliam 1988). There is an urgent need to identify and evaluate source and sink habitats (*a la* Donovan et al. 1995) within agroecosystems in order to provide meaningful recommendations for land-use practices and agricultural policy. Studies have shown that occurrence and density, when taken alone, may be misleading indicators of bird habitat quality and productivity (Van Horn 1983, Johnson and Temple 1986, Vickery et al. 1992). Although bird abundances and nest densities may be much higher in strip-cover than in block-cover habitats (see studies cited above), the high nest failure rates associated with many narrow, linear habitats may limit their value in bird conservation and management (Major et al. 1999). Some sources of nest failure, however, can be reduced through appropriate land-use decisions (e.g., deferred mowing, establishing minimum strip widths).

Setting Management Objectives

The presence of shrubs and trees in strip-cover habitats increases bird abundance and species richness in agricultural landscapes (Best 1983, O'Conner 1984, Lack 1987, Paruk 1990). If the land-use objective is to enhance bird species diversity in intensively farmed areas, the establishment and protection of woody plants in some strip cover is a reasonable management goal. On the other hand, if the objective is the conservation of grassland birds, maintaining woody vegetation in strip cover usually would be considered a liability (see Proximity to Woody Vegetation section, O'Leary and Nyberg 2000).

Dickcissel nest with four parasitic cowbird eggs (L. Best)

Because of their narrow, linear configuration, strip-cover habitats are better suited for generalist and/or edge species than for habitat interior and edge sensitive species. For species highly sensitive to habitat area or width, provisioning strip-cover habitats will do little for their conservation. Furthermore, although some grassland bird species of management concern (Sample and Mossman 1997) are present in strip-cover habitats, they compose a smaller proportion of the avian community in strip cover than in block-cover habitats. In the Iowa studies, for example, grassland birds of management concern composed 52% of the bird community in block-cover CRP fields but only 35, 19, and 38% of the avifauna in grassed waterways, herbaceous roadsides, and terraces, respectively (Table 1).

The Relative Importance of Strip-cover Habitats

Strip-cover habitats constitute a significant proportion of the habitat available to birds in areas where agriculture is widespread and agricultural practices are intense (Williamson 1967, Warner 1994). One potential advantage of strip-cover habitats is that they are, or at least through appropriate management can be, free of some of the anthropogenic disturbances characteristic of cropland (cultivation, mowing, pesticide application, etc.). Furthermore, earliest nesting efforts by some grassland birds may not be directed at strip-cover habitats (Warner et al. 1987); thus, such habitats may serve as important renesting sites for birds that have experienced nest failure elsewhere (Bryan and Best 1994). For example, after hayfields are mowed, some birds resume breeding in other uncut cover (Albers 1978, Sample 1989, Bollinger et al. 1990, Igl 1991).

Concluding Comments

Strip-cover habitats are not a panacea for birds in agricultural landscapes, but they can make an important contribution. The degree to which strip cover attracts various bird assemblages depends upon how it is designed and managed. Strip-cover habitats have the potential to greatly enrich the avifauna, particularly in areas subjected to intensive agriculture, and they are unrivaled in the bird densities they can contain. Whether these habitats serve as ecological traps or important production areas, however, will depend upon enlightened decisions in their placement, design, and management.

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Table 1. Bird use of Iowa CRP fields, rowcrop fields, and strip-cover habitats associated with rowcrop fields during the summer breeding season. Except for fencerows, abundance values are expressed as birds observed/census count/100 ha. Values < 1 were excluded.

			Fencerows					
Bird Species	**CRP Fields**	**Rowcrops**	**Herbaceous**	**Scattered Trees/Shrubs**	**Continuous Trees/Shrubs**	**Grassed Waterways**	**Herbaceous Roadsides**	**Grassed Terraces**
Mallard			•					
Northern harrier*								
Red-tailed hawk						2	3	
American kestrel							2	
Northern bobwhite						1		4
Ring-necked pheasant	6•	2•	•			36•	8•	11•
Gray partridge						6	42•	
Killdeer	1	2•				19	1	1
Solitary sandpiper							1	
Upland sandpiper*	1•					5	2	4
Rock dove							1	
Mourning dove	1•	•	1	2	5•	14	7	4•
Yellow-billed cuckoo				1	3			
Black-billed cuckoo				4•	2			
Great horned owl						3		
Chimney swift								
Northern flicker				1	6•			
Red-bellied woodpecker				1				
Red-headed woodpecker				1	2		1	
Downy woodpecker					2			
Least flycatcher					4			
Eastern kingbird	1	1	4	2	5	6	18	1
Horned lark		12•	3			50	5	
Tree swallow						10		
Barn swallow	6	4		2		202	29	19
Cliff swallow						7		
Blue jay				1•	2			6
American crow		2			11	4	2	
Black-capped chickadee				2•	7	1		
Sedge wren*	3•					1•		2
Marsh wren							5	
House wren					4		1	
American robin		2		9•	7•	35	49	9•
Wood thrush						1		
Gray catbird				•	1•			
Brown thrasher				3•	1•	7	10	12
Loggerhead shrike*				2			2	
European starling					1•	22	3	
Common yellowthroat	11•	1	1		4	63•	4•	1
Wilson's warbler					1			
House sparrow				4	21	24	28	
Bobolink*	38•					7		
Eastern meadowlark*			1			2		
Western meadowlark*	6•	1				154•	99•	10
Red-winged blackbird	109•	20•	•	2•		513•	765•	173•
Brewer's blackbird*				18	7			
Common grackle	1	6		2	1	47	24	7

—Continued

Table 1. Continued—Bird use of Iowa CRP fields, rowcrop fields, and strip-cover habitats associated with rowcrop fields during the summer breeding season. Except for fencerows, abundance values are expressed as birds observed/census count/100 ha. Values < 1 were excluded.

			Fencerows					
Bird Species	**CRP Fields**	**Rowcrops**	**Herbaceous**	**Scattered Trees/Shrubs**	**Continuous Trees/Shrubs**	**Grassed Waterways**	**Herbaceous Roadsides**	**Grassed Terraces**
Brown-headed cowbird	10•	11•	35	18	25	117•	328•	17
Northern oriole					2	1		2
Northern cardinal				•	2•	1		
Rose-breasted grosbeak				1		1		
Indigo bunting			2		20	16	1	
Dickcissel*	58•	•	4	8	3	362•	52•	95•
American goldfinch	2•	1		5	4	25	10	2
Savannah sparrow*	8•					15	12	2
Grasshopper sparrow*	49•	1				106•	1	
Henslow's sparrow*								
Vesper sparrow*	1•	12•	24	8	8	126•	161•	46
Chipping sparrow					1		5	3
Field sparrow*						2•		13
Song sparrow	3•	1	•	4•	16•	95•	38•	9
Number of species	33	34	9	23	30	48	35	26
Total abundance	315	84	76	99	171	2198	1670	463
Number of nesting species	15	2-8	7	13		11	9	5
Nest density (#/100 ha)	263	15	–	–	–	1086	1176	648

Sources of information: Rowcrop fields (Patterson and Best 1996, unpubl. data); **CRP fields (**Patterson and Best 1996, unpubl. data); **Fencerows** (Best and Hill 1983, Best 1983), values expressed as birds/census count/10,000 m; **Waterways (**Bryan and Best 1991); **Roadsides (**Camp and Best 1993); and **Terraces (**Hultquist 1999).

• = Known to nest in that particular habitat. **References:** Shalaway (1985), Best (1986; only tilled fields), Bryan and Best 1994, Camp and Best (1994), Patterson and Best (1996), Hultquist (1999).

* = Grassland bird species of management concern (Sample and Mossman 1997).

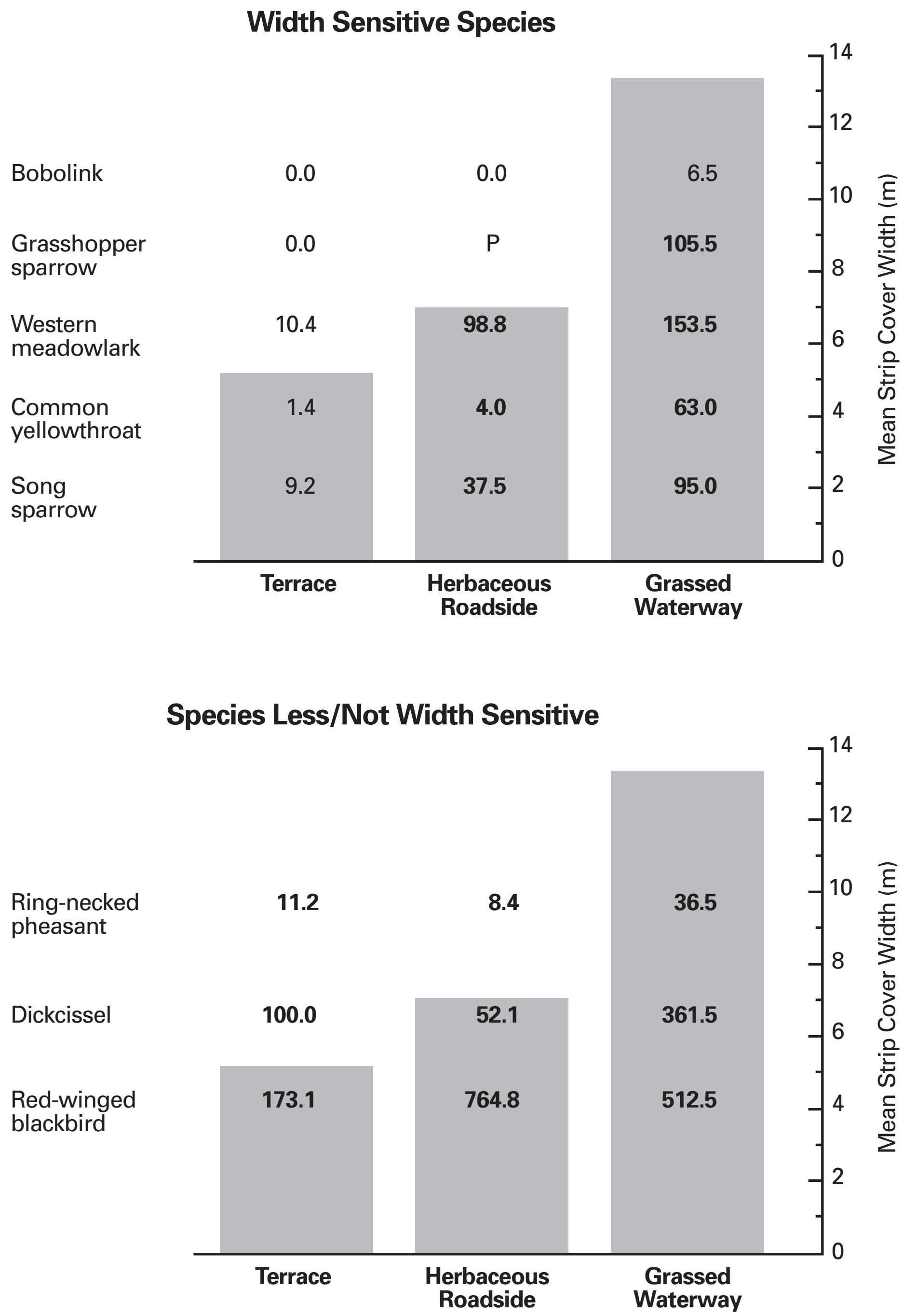

Figure 1. Abundance values (numbers/census count/100 m) for selected bird species in three strip-cover habitats in Iowa agricultural landscapes. Bold numbers indicate documented nesting. Histogram bars represent mean strip widths. References: Bryan and Best 1991, 1994; Camp and Best 1993, 1994; Hultquist 1999.